BINOD BIHARI MAHATO KOYLANCHAL UNIVERSITY

SYNOPSIS ON

"STRUCTURED AND UNSTRUCTURED STUDY ON A NEW ECOSYSTEM OF *Aedes* Sp. IN WESTERN PART OF WEST BENGAL AND CHHOTANAGPUR PLATEAU OF JHARKHAND"

FOR

DOCTOR OF PHILOSOPHY

IN

FACULTY OF SCIENCE (ZOOLOGY)

UNDER THE SUPERVISION OF

PROF. SHAILENDRA KUMAR SINHA
HEAD, UNIVERSITY DEPT. OF ZOOLOGY
BBMKU, DHANBAD

Co-Supervisor

DR. P. K. BANDYOPADHYAY (AFFILIATED RESEARCH GUIDE
OF ENVIRONMENTAL SCIENCE, THE UNIVERSITY OF BURDWAN)
ASSOCIATE PROFESSOR OF BOTANY/ENVIRONMENTAL SCIENCE
BURDWAN RAJ COLLEGE, BURDWAN

SUBMITTED BY

ARUP GHOSH

"STRUCTURED AND UNSTRUCTURED STUDY ON A NEW ECOSYSTEM OF *Aedes* Sp. IN WESTERN PART OF WEST BENGAL AND CHHOTANAGPUR PLATEAU OF JHARKHAND"

INTRODUCTION:

According to WHO mosquitoes are one of the deadliest animals in the world", it causes millions of deaths every year. **[1]**
It is not only known to Biologist rather known to all general people also that in the life cycle of mosquito Water Bodies are inevitable factor/parameter. **[2]**
Again, in another report/fact sheet of ***Aedes*** sp. by WHO it is also intimated that preferred dominating zone of Aedes is restricted mainly to the Urbanized Zone. **[1]**

It is observed apparently that there are very limited number of water bodies are situated in the urban sector where mosquito can grow and develop to such an extent which can lead to a condition of epidemic! in spite of adopting war-field basis precaution and measures by the proper authority and administration. **[2]**
Under this circumstance an understanding has been came into consideration that there must be a major missing link in the life cycle of *Aedes sp.* and those mosquitoes are utilizing an alternate ecosystem which is still unknown and hidden, causing a severe type of health problem mainly in the urban area.In search of that missing link a preliminary study was conducted along with some other coinvestigator on this field and independently by the investigators. **[2] / [3]**
From that study and observation, it has been revealed that possibly in the urban area "Septic Tank Ecosystem" is the causative factor i.e. - Last Chamber of Multi-Segmented Septic Tank are sufficient enough to *Aedes* for enjoying smooth and undisturbed environment for their growth and development **[3]**

2. REVIEW OF LITERATURE:

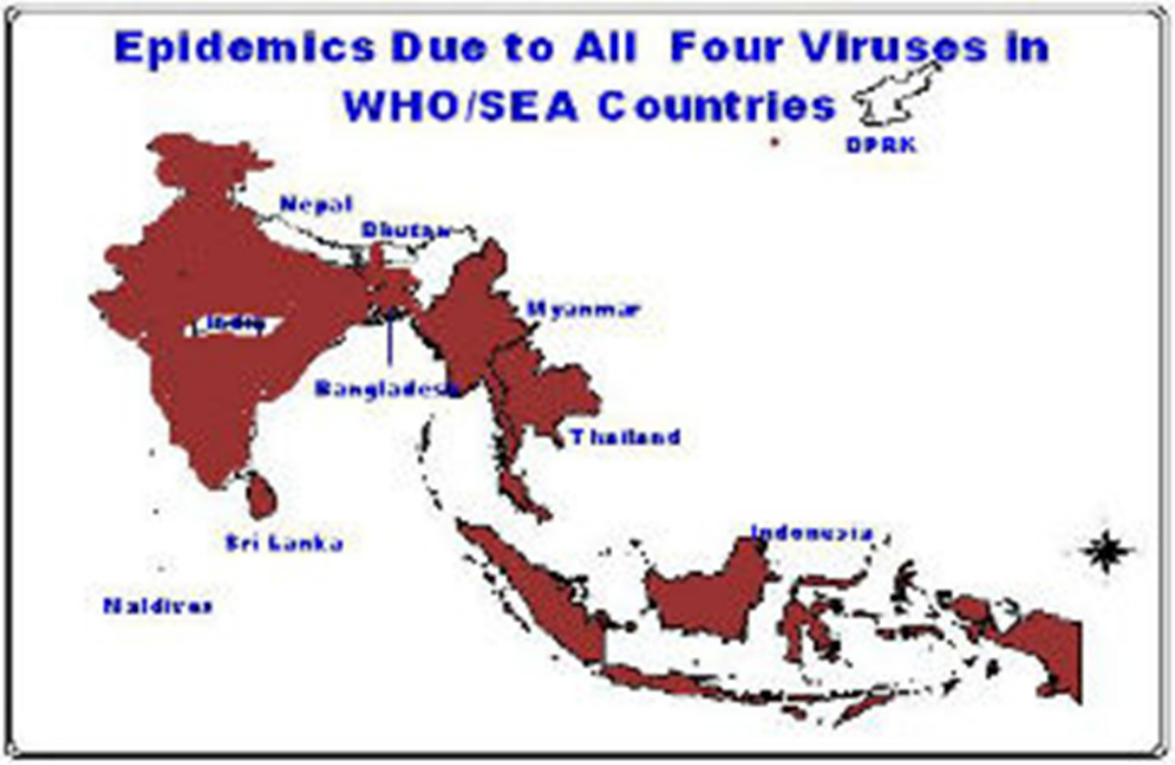
"*Aedes sp.* mosquito can't develop in the **dirty** water, it breed and develop only in the clean and **clear** water". **[4]** it is widely accepted theory regarding the life cycle of this notorious and dreaded vector.

As per **"WHO Comprehensive Guidelines for Prevention and Control of Dengue and Dengue Haemorrhagic Fever**" – Page No-71: "Throughout most of South-East Asia, Ae. aegypti oviposits almost entirely in domestic and man-made water receptacles. (y) These include

a multitude of receptacles found in and around urban environments (households, construction sites and factories) such as water-storage jars, saucers on which flowerpots rest, flower vases, cement baths, foot baths, wooden and metal barrels, metal cisterns, discarded tyres, bottles, tin cans, polystyrene containers, plastic cups, discarded wet-cell batteries, glass containers associated with "spirit houses" (shrines), drainpipes and ant-traps in which the legs of cupboards and tables are often rested". **[2]**

Again in another report in 'Down to Earth' – Mosquito Matter –"The blood-sucking pest is altering itself with changing environment. But studies on it are few and far between.
'Dengue-causing *Aedes aegypti* mosquito breeds in stagnant water containers such as drums, buckets, pots and flower vases. Surveys by NIMR [National Institute of Malarial Research-New Delhi] reveal that now *Aedes aegypti* also breeds in wells and tree holes, usually found in rural areas" **[5]**
More over this theory is also being followed for control and prevention of *Aedes Sp*. borne community health problem all over the world, like Indonesia, Ethiopia, Thailand, Miami-Florida, India etc **[6,4,7,5,8,2,9,]**
But consequences are possibly about to nil and day after day conditions are snaking to the horrible situations. Followings are some information from WHO which are supportive to the above statement. **[1,10]**

- **"Before 1970, only nine countries had experienced severe dengue epidemics. The disease is now endemic in more than 100 countries".**
- **"Africa, the Americas, the Eastern Mediterranean, South-east Asiaand the Western Pacific are affected out of which South-east Asia and the Western Pacific regions are the most seriously affected"**



So it is revealed that conditions are really severe and alarming that's beyond doubt.

NICHE (Ecosstem) OF *AEDES* MOSQUITO :

Niche conservatism of *Aedes:*

Aedes albopictus and *Aedes aegypti*, two mosquito species that are listed among the world's worst invasive alien species (Global Invasive Species Database, IUCN) and that are competent vectors for several diseases16, were used as model species to assess whether climatic niches between native and non-native ranges have changed. *Aedes albopictus*, native to Southeast Asia, is regarded to be one of the fastest spreading invasive species worldwide. Its invasion success has been highly promoted by increasing global trade and tourism. In addition to that, the area with suitable climatic conditions for the species is expected to expand under climate change (e.g. Cunze *et :al*.).

The closely related *Ae*. *aegypti*, native to Africa , is similarly widespread but has a different history of invasion. While the global spread of *Ae*. *albopictus* took place mainly within the last 30–40 years, the spread of *Ae*. *aegypti* into tropical and subtropical regions outside the African continent took place in conjunction with the increase of slave trade in the 16th and 17th century. Today, *Ae*. *aegypti* is restricted to tropical and subtropical regions in which temperatures remain relatively warm throughout the year. Records from moderate climate zones are still missing or

rare and may be the result of the species' domesticity (feeding, mating, oviposition indoors) (e.g. Gloria-Soria *et al*.).

According to Guisan *et al*. differences in realized niches between native and non-native ranges can be ascribed to either a) adaptive evolutionary changes in the physiological tolerance of the species during the invasion process, b) a broad fundamental niche and thus, preadaptation to conditions not available (anymore) within the native range but available within a non-native range, c) changes in biotic interaction and/or d) limitations in dispersal ability of the species **[11]**

The ecological niche of a species can be defined as the range of environmental and biotic conditions within which its populations can persist without immigration (Hutchinson, 1957).**[12]**

PRE-EXISTING :

The immature stages are found in water-filled habitats, mostly in artificial containers closely associated with human dwellings and often indoors.

These include a multitude of receptacles found in and around urban environments (households, construction sites and factories) such as water-storage jars, saucers on which flowerpots rest, flower vases, cement baths, foot baths, wooden and metal barrels, metal cisterns, discarded tyres, bottles, tin cans, polystyrene containers, plastic cups, discarded wet-cell batteries, glass containers associated with "spirit houses" (shrines), drainpipes and ant-traps in which the legs of cupboards and tables are often rested".

Ae. aegypti breed indoors and are capable of biting anyone throughout the day. The indoor habitat is less susceptible to climatic variations and increases the mosquitoes' longevity.

Ae. aegypti niche and trophic interactions: The mosquito Ae. aegypti has a relatively narrow niche with limited trophic interactions.

The anthropophilic form of Ae. aegypti, Ae. aegypti aegypti, utilises flooded artificial containers as habitat for larvae and pupae. It is this form that has become established in most tropical and subtropical areas globally and is the primary vector of dengue, Zika and several other viruses. The original sylvan form of Ae. aegypti, Ae. aegypti formosus, occurs in sub-Saharan Africa where natural containers such as flooded tree holes are the dominant larval habitat (Lounibos, 1981). A plethora of man-made objects composed of plastic, rubber, metal, concrete, masonry and ceramics have been shown to hold water, capture nutrients and produce Ae. aegypti (Ritchie, 2014). Within these flooded containers, larvae graze on the surface of the container, feeding on fallen detritus (typically leaves) and bacteria and algae that have grown on it. Protein sources such as insects, seeds, fruit and even dead conspecific mosquito larvae are fed upon. However, MANY OF THESE CONTAINERS ARE NUTRIENT POOR, ESPECIALLY COVERED CONTAINERS SUCH AS WATER STORAGE TANKS, AND TYPICALLY PRODUCE STUNTED ADULTS. THE RESTRICTION OF NUTRIENTS, COUPLED WITH HIGH LARVAL POPULATIONS BEYOND THE CARRYING CAPACITY OF THE CONTAINER, REDUCE LARVAL GROWTH AND PUPATION VIA **DENSITY-DEPENDENT** REGULATION (Hancock *et al*., 2016). Indeed, it is the sudden input of **protein** from, for example, a cricket that falls into and drowns within the container, which can lead to a surge in

larval growth, pupation and adult emergence. There is a very limited number of species known to feed upon Ae. aegypti larvae and pupae. Most artificial containers are small to medium in size, only intermittently flooded and thus do not maintain POPULATIONS OF PREDACEOUS AQUATIC INSECTS OR VERTEBRATES SUCH AS FISH AND AMPHIBIANS. WHILE MANY OF THESE AQUATIC PREDATORS CAN EAT MOSQUITO LARVAE, THEY ARE UNCOMMON IN MOST AE. AEGYPTI HABITAT. In some larger containers, dytiscid beetles AND dragonfly naiads can occur and feed upon mosquito larvae, while fish and tadpoles have been propagated and released in large water storage containers to control Ae. Aegypti. Among the many kinds of mosquito that do not consume blood, mosquitoes of the genus Toxorhynchites oviposit in artificial containers and selectively feed upon mosquito larvae (Trpis, 1973) being Ae. aegypti larvae as well as from other container mosquito species such as Ae. albopictus and Ae. notoscriptus. Copepods of the genus Mesocyclops will actively predate first instar larvae of Ae. aegypti.

ANTHROPIC HABITATS: Increase in the size and population density of major cities place increasing demands on infrastructure and essential services, particularly in developing countries. The response to these demands may dramatically alter the suitability of a locality for urban mosquito breeding. AN ABSENCE OR IRREGULARITY OF WATER SUPPLY WILL LEAD TO AN INCREASE IN DOMESTIC WATER STORAGE PRACTICES WHICH, IN TURN, WILL ALTER THE LANDSCAPE OF POTENTIAL AE. AEGYPTI HABITAT, perhaps providing a far more regular or abundant supply of larval sites. The effects of topographic features of urban environments on Ae. aegypti behaviour are not fully understood; however, Reiter *et al.* (1995) noted that buildings were not an impediment to Ae. aegypti flight. Certain results indicate that urban landscape does contain barriers to dispersal (Reiter *et al.,* 1995; Chadee, 2004; Valerio *et al.,* 2012), and this affects the mosquito population structure. Such information can be useful to agencies in charge of vector control for better targeting mosquito populations and areas of higher risk within control zones. Understanding the role of landscape features on population dispersal is likely critical to achieving success with any Ae. aegypti control strategy.

ABIOTIC REQUIREMENTS AND TOLERANCE: Considerable variation in adult size occurs as a result of habitat conditions such as water quality, food availability, and crowding during mosquito larval breeding (Nasci, 1991). The adult size strongly influences various aspects of mosquito life history: survivorship (Pumpuni and Walker, 1989), mating success (Yuval, Wekesa and Washino, 1993), blood meal size (Xue, Edman and Scott, 1995), parous rate (Haramis, 1983), fecundity (Packer and Corbet, 1989), dispersal (Renshaw, Service and Birley, 1994) and longevity (Feinson and Spielman, 1980). AMONG ABIOTIC AND BIOTIC FACTORS, HIGH TEMPERATURE AND LOW NUTRITION IN THE DEVELOPING STAGES OF MOSQUITOES GENERALLY RESULT IN SMALL ADULTS. WHILE TEMPERATURE, HUMIDITY AND RAINFALL HAVE OVERT IMPACTS ON MOSQUITO ADULT SURVIVAL AND ECOLOGY, OTHER CLIMATIC FACTORS SUCH AS PHOTOPERIOD AND WIND VELOCITY MAY ALSO BE INFLUENTIAL.

IMPORTANTLY, IT IS NECESSARY TO CONSIDER THAT THESE METEOROLOGICAL CONDITIONS HAVE A COMBINED EFFECT ON THE SURVIVAL AND **DEVELOPMENT OF MOSQUITOES** and that it is difficult toexamine the potential impact of these factors independently as a consequence (Jansen and Beebe, 2010).

AQUATIC: Ae. aegypti prefers clean water found in many types of domestic containers inside or near human dwellings (Nazri *et al*., 2013). The Aedes mosquito larvae require standing water to complete their growth cycle, therefore, any body of standing water represents a potential Aedes mosquito breeding site for mosquito larvae to mature. Water quality affects the productivity of a potential mosquito breeding habitat. Typically, greater numbers of mosquitoes are produced in water bodies with poor circulation, higher temperatures and higher organic content than in water bodies having good circulation, lower temperatures and lower organic content (Focks *et al*., 1993; Murrell and Steven, 2008). Aquatic habitats for Ae. aegypti are containers in which eggs develop into adult mosquitoes. Mosquitoes lay eggs on the walls of water-filled containers in or around the house. The eggs hatch when submerged in water and can survive desiccation for months There is a great variety of man-made containers on backyards or patios that collect rainwater or that are filled with water by people. Artificial or natural water containers (water storage containers, flower pots, discarded tires, plates under potted plants, cemetery vases, flower pots, buckets, tin cans, clogged rain gutters, ornamental fountains, drums, water bowls for pets, birdbaths, etc.)

TERRESTRIAL : Studies of associations between climate parameters and Ae. aegypti are complicated by the dependence of the mosquito on humans, especially its preference for human blood and its adaptation to use artificial containers as larval development sites (Focks and Alexander, 2006; Tun-Lin et al., 2009). Ae. aegypti is the major urban vector of DENV worldwide. OVER THE LAST 25 YEARS, THERE HAS BEEN A GLOBAL INCREASE IN BOTH THE DISTRIBUTION OF AE. AEGYPTI AND EPIDEMIC DENV ACTIVITY (Mackenzie, Gubler and Petersen, 2004). Historically, Ae. aegypti has been thought to be able to establish in regions between the northern January and southern July 10°C isotherms, while more recent studies suggest that the 15°C yearly isotherm is a better estimate**. [12]**

NEW ECOSYSTEM (NICHE) : In case of pre-existing ecosystem where **capitalized (Upper-Case) sentences** have given stress on the so many negative points for the smooth and uninterrupted developments of *Aede*s aegypti mosquito in the pre existing ecosystem which have been overcome in the SEPTIC TANK ECOSYSTEM.

In SEPTIC TANK ecosystem all those adverse points are absent: **[13]**

]Regarding nutrition 3rd chamber (Last Chamber) of septic tank is highly nutrient rich water bodies suitable for larva and pupa of even high density [because it is getting continuous charging of decomposed excreta and associated biota]

1. Complete absence of predaceous aquatic animals for safe growth of all stages of mosquito.
2. Continuous supply of required water for smooth processing of septic tank excreta processing [after each and every use of latrine about minimum 10 ltrs of water is used through out the year]
3. Regarding ABIOTIC FACTORS – Temperature, Humidity, Wind Flow, Excess Rainfall : all parameters are highly regulated and controlled unlike any other manmade water bodies
4. Meteriological Conditions : Aedes using this environment as natural AIR-CONDITIONED military bunker for its safe and smooth growth.
5. No any mosquito controlling measures effect its life cycle
6. No chance of flooding its egg and larva by excess rainfall during rainy season
7. No adverse effect of any system of natural control of mosquito development

In last it can infer that in its long and continuous changing of life cycle Aedes is smart enough to change and adapt any climatic condition as follows

a) adaptive evolutionary changes in the physiological tolerance of the species during the invasion process,

b) a broad fundamental niche and thus, preadaptation to conditions not available (anymore) within the native range but available within a non-native range,

c) changes in biotic interaction and/or

d) limitations in dispersal ability of the species.

3. PROBLEM TO BE INVESTIGATED:

"*Aedes sp.* mosquito can't develop in the **dirty** water, it bred and develop only in the clean and **clear** water" (1) - it is widely accepted theory regarding the life cycle of this notorious and dreaded vector

i. To overrule the above theory a research design has been framed out to establish the HYPOTHESIS on strong ground that "**Aedes mosquito is able to develop in the so called non-clean water of Septic Tank" .**
ii. To establish the hypothesis of the Study, a survey work would be carried out at Department of Zoology, BBMK University, Dhanbad along with some other associated laboratory (13) and a study on alternative pathway of life cycle of ***Aedes*** sp. will also be carried out.
iii. Study will be conducted to establish a strong and complicated interaction between Aedes sp .and Septic Tank, an inevitable component of **Contemporary Ecology** of

modern as well neat and clean **Urban life,** under which situations Aedes sp. performing the role of entomological vector silently as well uninterruptedly and creating a severe community health problem all over the world.

.4. OBJECTIVE:

Objectives are as follows:

1. Through detail study and survey, it is to be reinvestigated the previous study in more elaborate aspect to establish and authenticate the hypothesis into theory
2. To generate more and more data to establish the hypothesis on a strong and scientific base to Overrule the conventional concept that – 'Aedes Mosquito Develop Only in Clean Water'
3. To collect data, two types of approach will be applied e.g. Structured (Quantitative) Approach – to explain the matter explicitly and Unstructured (Qualitative) Approach – to describe the matter implicitly.
4. To establish the universality of data, geographically two different states have been selected for the study and thesis work.
5. To establish a scientific theory through which it can confidently suggest for preventing the growth and development of *Aedes*.

5. MOTIVATION:

The life cycle of *Aedes* Sp. is not yet fully clear, there are obviously some MISSING LINK. Investigator has to be revealed that mistry during the study. There is a complex interaction between Aedes sp .and Septic Tank. This Contemporary Ecologicalproblem of modern Urban life must have to be exposed out for the greater interest of the public health problem of the world as well *Aedes* Sp. mosquito borne Endemic control point of view also like Dengue, Chikungunya, Yellow-Fever, Zika etc. .

6. RESEARCH TOOL AND METHODOLOGY:

SITE OF STUDY**:** Study would be conducted at the following mentioned areas

1. Different site of western part of West Bengal like , Asansol, Burnpur, Durgapur, Purulia, Raghunathpur, Pandaveswar etc. susceptible to Aedes sp. borne community health Problem

2. Secondly Chhotanagpur plateau of Jharkhand like, Dhanbad, Hazaribagh, Jamshedpur, Ranchi, etc.

1. <u>Structured Approach</u>

[Quantitative Study i.e. it can be explained explicitly] **[14]**

: Random collection of adult mosquitos from outlet of septic tank by using a newly designed Mosquito Trapping Cage/Net to apparently determine either the tank is mosquito infested or not? because all septic tank are not *Aedes sp.* infested.**[3]**

Which septic tank found infested with *Aedes*, to be taken into consideration for collection of outlet water for 24-48 hrs. into a container fitted with a fine cloth and subsequent nurturing for identification of genus of mosquito as well as for confirmation of approach. **[13]**

2.<u>Unstructured Approach</u> [Qualitative Study, i.e. it can be explained implicitly]: By collecting experience, feelings, related advice, criticism and remarks from general people through **predesigned questionnaire. [15]**

3. Analysis of Hydro Chemicals and Microbiological Status of the Reserved Water of Septic Tank:

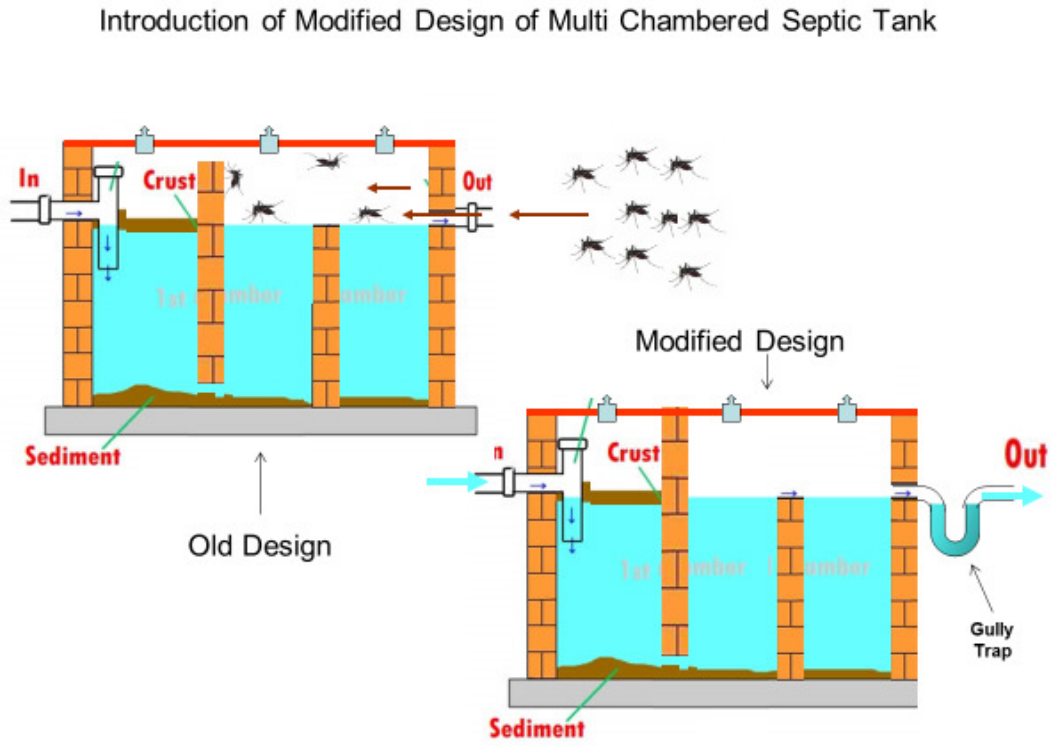
Study will be done on Hydro chemical and Microbiological status of the water of proposed ecosystem (**<u>New*Contemporary Ecosystem of Multi -Chambered septic Tank of Urban and Rural Area i.e. - Resting and Nesting Site of Aedes sp. Mosquito*</u>*[13]*

Structured Approach Regarding New Ecosystem of *Aedes sp*. Mosquito [3]

Nurturing of Water collected from Septic Tank Outlet for Development of Adult *Aedes* in the Laboratory

STRUCTURED STUDY-II (Confirmatory Test)

Structured Approach Regarding New Ecosystem of *Aedes sp*. Mosquito [13]



Modern Septic Tank Chamber is the New Ecosystem of *Aedes* sp. Being Used as Resting and Nesting Site of *Aedes Sp*. for All Around the Year. [13]

7.Significance of Proposed Work (SOCIO-ECONOMIC ASPECT):

From the result of this study society would be able to get success in future for effectively control the severe health problem like Zika, Dengue, Encephalitis, etc. caused by the *Aedes sp.*mosquito

1.First of all the hypothesis is to be established on strong ground that Aedes mosquito is able to develop in the so called non-clean water of Septic Tank .

2. Breaking the contamination chain between Aedes and Hunan population

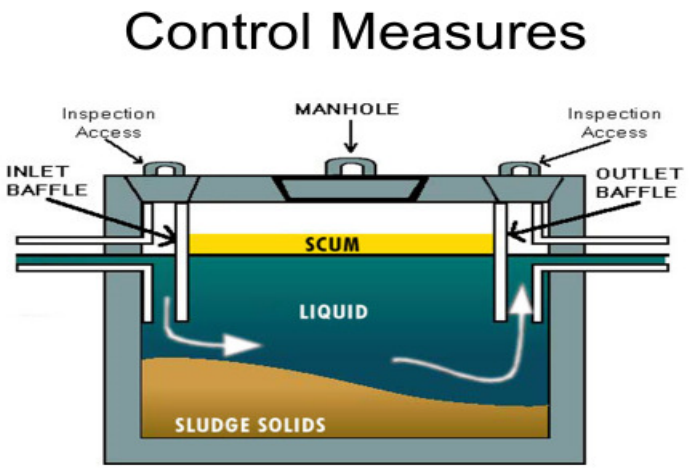
3. To Restrain the development of mosquito in the Septic Tank by breaking the entry point of mosquito

This contemporary ecological problem is very much significant and relevant from "Life Security on Earth" Point of view also.

8. FUTURE PROSPECT:

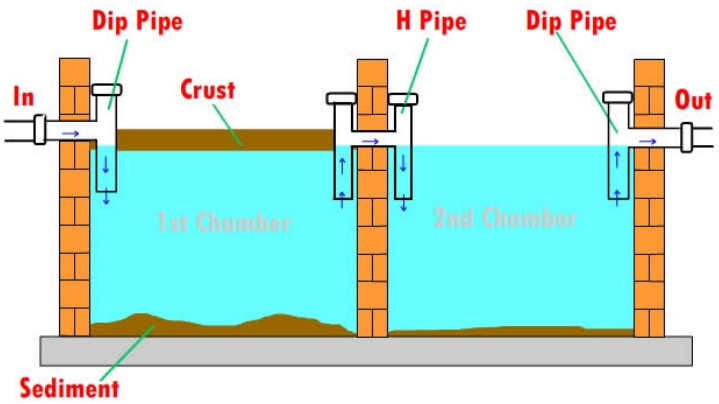
DEVELOPMENT OF DESIGN OF SEPTIC TANK : [13]

i. For New Septic Tank : It must be Water Tight Closed System Tank



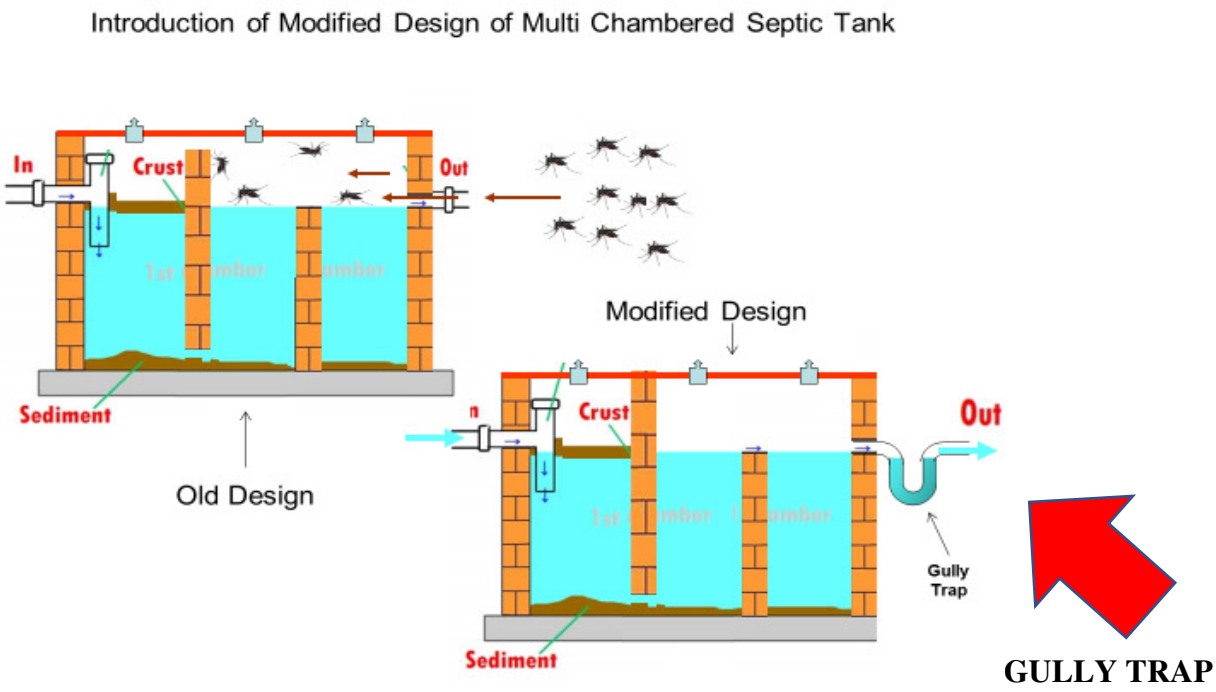
Introduction of Single Chambered Septic Tank

Water Tight Closed System Single Chambered Septic Tank



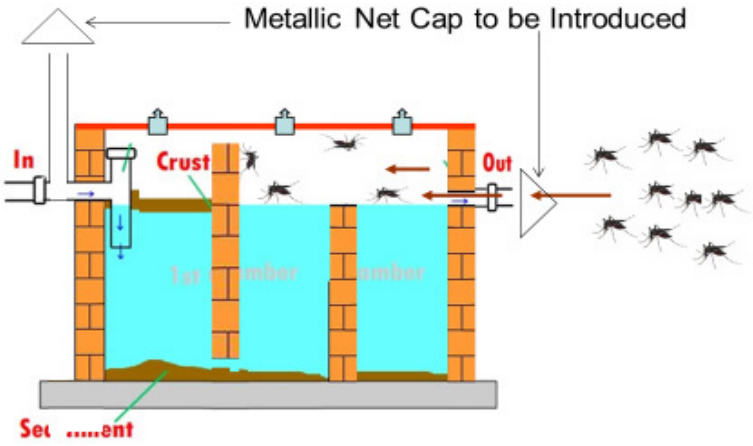
Water Tight Closed System Multi Chambered Septic Tank [13]

ii. For Old Existing Septic Tank



GULLY TRAP

'U SHAPED ' GULLY TRAP TO MAKE SEPTIC TANK WATER TIGHT CLOSED SYSTEM [13]



FIXING OF METALIC NET IN THE INLET AND OUTLET PORT OF THE SEPTIC TANK [13]

9. LIMITATION :

Survey works sphere will remain restricted within only two states of India, so it will not reflect a universal result.

In future working sphere can be expanded to a greater extent. for versatile observations and result.

10. TENTATIVE CHAPTERIZATIONS:

Chapter 1: Introduction and Literature Review

This chapter will reflect the basic concept of the subject on which the investigators will proceed in future work. In another term it is the labelled covering of a packaged product from here one can get the estimated picture of the work.

Literature review is the foundation stone of the whole study. How much study and research work have been done on a particular problem / direction can be evaluated frwhat has to bom literature review. It provides immense idea that what has already been done and what has yet to be done for a particular subject.

Chapter 2 : Unstructured Study (Qualatitive Mode of Approach)

A random investigations would be conducted at the selected site of study through personal interview and by using predesigned Questionnaire with different personalities to share gather their experiences and remarks on mosquitoes and other related problems.

Chapter 3 : Screening Out of Water Reservoir Remain Active all Around the Year

Investigator will make study to collect data as well physical verifications regarding the possible breeding ground of *Aedes* Sp., both natural and manmade container remain active all around the year as well as seasonal also.

Chapter 4 : Structured Study – I (Quantitative Mode of Approach)

It may also called as **PRIMARY General Test**. It would be conducted as RAPID TEST to ascertain the *Aedes* Sp. mosquito infestation chance of a Septic Tank Within 24-48 hours.
A specially designed adult mosquito trapping cage will be fitted at the outlet port of the selected septic tank. On the basis of positive result, infestivity of mosquito, next step will be followed. All the relevant data will be collected and recorded for subsequent analysis.

Chapter 5: Structured Study - II (Quantitative Mode of Approach)

It is also called as **SECONDARY Confirmatory Test** Those septic tanks would be found positive (mosquito infestation) from Structured Study – I would be selected for collection of water from the outlet port of the tank by fixing a container for about 24 hours. For subsequent and protected nurturing at laboratory for confirming the Genus of the mosquito and further necessary study. Relevant data will be collected and recorded for analysis in future.

Chapter 6:Analysis of Hydro Chemicals and Microbiological Analysis of the Reserved Water of Septic Tank:

It is very much important to know about the chemical and biological status of the reserved water of the septic tank. Different Hydro-Chemical and Biological analysis will be incurred in the laboratory. It will direct the study to reach a conclusive result that whether the tank water is favourable to mosquito or it has made an adaptation to a adverse condition.

Chapter 7: Result Analysis

It would be the most vital part of the total study, result will be reflected through tabular form and through different graphical representation.

Chapter 8: Discussion and Conclusion

This part will focus the main findings of different study like Unstructured, Structured and Hydro Chemical and Biological studies. On the basis of different confirmed results a **THEORY** will be established on the basic frame of proposed **HYPOTHESIS**.

11. REFERENCE:

(1). WHO. 2019. Dengue Fact Sheet, 15th April -2019, www.searo.who.int/entity/vector_borne_tropical_disease/data_fact sheet/dengue

(2). World Health Organization.2011. Comprehensive guidelines for prevention and control of dengue and dengue hemorrhagic fever. 2011; Available from: http://apps.searo.who.int/pds_docs/B4751.pdf [WHO 2011

(3) Sinha S, Ghosh A, Badyopadhyay PK. 2020. Aedes sp., Community Health and Septic Tank: A Survey from Contemporary Ecology and Entomological Vector Point of View - Paper Presented at : 32nd All India Congress of Zoology (AICZ) and International

Conference on “Life Security of Earth” , 22 to 24 February , 2020; Organized by – Adarsh Institute of Management and Science, A.B.Road, Dhamnod (M.P.) India, & Zoological Society of India (ZSI) , In Collaboration with School of Life Science, Devi Ahilya Vishwavidyalaya, Indore, (M.P.)
(4). Faiz M, Nazri CD, Chua ST, Nurmahirah Z. 2016.Breeding Characteristics of Aedes Mosquitoes in Dengue Risk Area -,- - ASEAN-Turkey. Paper Presented at: ASLI (Annual Serial Landmark International) Conferences on Quality of Life 2016 ,AMER International Conference on Quality of Life, - AicQoL2016Medan25 – 27 February 2016, Medan, Indonesia - // -Faiz Madzlan et al. / Procedia - Social and Behavioral Sciences 234 (2016) 164 – 172
(5). Sood J, 2016. The blood-sucking pest is altering itself with changing environment. But studies on it are few and far between. Down To Earth (Magazine), Last Updated: Monday 25 April 2016.]- https://www.downtoearth.org.in › coverage › health › mosquito-matters-42
(6). Chareonviriyaphap T, Akratanakul P, Nettanomsak S, Huntamai S. 2003. “Larval habitats and distribution patterns of Aedes aegypti (Linnaeus) and Aedes albopictus (Skuse), in Thailand; , ,” Southeast Asian Journal of Tropical Medicine and Public Health, vol. 34, no. 3, pp. 529–535, 2003.
(7).Getachew D, Tekie H, Michael TG, Balkew M, Mesfin A,. 2015. Breeding Sites of Aedes aegypti: Potential Dengue Vectors in Dire Dawa, East Ethiopia. Research Article | Open Access .Volume 2015 |Article ID 706276 | 8 pages | https://doi.org/10.1155/2015/706276
(8). Thete KD, Shinde LV. 2013.”.“Survey of container breeding mosquito larvae in Jalna City (M.S.), India, Biological Forum, vol. 5, no. 1, pp. 124–128, 2013.
(9). Wilke ABB, Chase C, Vasquez C, Carvajal A, Medina J, Petrie WD & Beier JC. 2019. Urbanization creates diverse aquatic habitats for immature mosquitoes in urban areas, Scientific Reports volume 9, Article number: 15335 (2019), Published: 25 October 2019.
(10). WHO. 2019. The mosquito, 14th November 2019 - https://www.who.int/denguecontrol/mosquito/en/.
(11).Cunze S, Kochmann J, Koch LK, Klimpel S.2018. Niche conservatism of Aedes albopictus and Aedes aegypti - two mosquito species with different invasion histories. Nature : Sientific Reports : Published: 16 May 2018-https://www.nature.com/articles/s41598-018-26092-2#:~:text=Highest%20niche%20occupancies%20in%20non,ranges%2C%20with%20very%20low%20unfilling.

(12). OECD Library. 2018. Ecology of the mosquito Ae. Aegypti. SAFETY ASSESSMENTOF TRANSGENIC ORGANISMSIN THE ENVIRONMENT, VOLUME 8 © OECD 2018. Chapter 4. Ecology of the mosquito Ae. Aegypti -https://www.oecd-ilibrary.org/docserver/9789264302235-8-en.pdf?expires=1595341839&id=id&accname=guest&checksum=12A1CE405415BB959FCA9C81722A668B
(13). Chatterjee A, Mandal S, Biswas A, Ghosh A, Mondal SK. 2012. "A NEW ECOSYSTEM OF Aedes sp. MOSQUITO, THE VECTOR OF DENGU & CHIKUNGUNIA" - AN ORIGINAL SURVEY, OBSERVATION AND CONTROL. Paper Presented at: 19th West Bengal State Science and Technology Congress, 2012.
(14).Kumar R.2010. Research Methodology - 3rd edition , - a step by step guide for beginners:Published by SAGE Publications Ltd (2010) ,. Chapter 8- Selecting a Study Design.
(15). Gupta N, 2019.A Presentation on Developing Questionnaire. Supplied during Ph.D. Course Work at BBMKU, Dhanbad, Jharkhand -2019